

People also are becoming increasingly reliant on ATMs. Besides bank and retail transactions, ATMs provide an increasing number of other services, such as employee information processing and distribution of government payments. ATM design improvements have increased reliability and simplified repair tasks, reducing the number and extent of repairs. Opportunities for ATM repairers should be available, primarily arising from the need to replace workers who leave the specialty, rather than from employment growth.

Conventional office machines, such as calculators, are inexpensive, and often are replaced instead of repaired. However, digital copiers and other newer office machines are more costly and complex. This equipment often is computerized, designed to work on a network, and able to perform multiple functions. The growing need for repairers to service such sophisticated equipment should result in job opportunities for office machine repairers.

### Earnings

Median hourly earnings of computer, automated teller, and office machine repairers were \$15.08 in 2000. The middle 50 percent earned between \$11.80 and \$19.20. The lowest 10 percent earned less than \$9.50, and the highest 10 percent earned more than \$23.42. Median hourly earnings in the industries employing the largest numbers of computer, automated teller, and office machine repairers in 2000 are shown below.

Professional and commercial equipment .....	\$15.28
Computer and data processing services .....	15.05
Radio, television, and computer stores .....	13.16

### Related Occupations

Workers in other occupations who repair and maintain electronic equipment include broadcast and sound engineering technicians and radio operators; electronic home entertainment equipment installers and repairers; electrical and electronics installers and repairers; industrial machinery installation, repair, and maintenance workers; and radio and telecommunications equipment installers and repairers.

### Sources of Additional Information

For information on certification programs, contact:

- Computing Technology Industry Association, 450 East 22nd St., Suite 230, Lombard, IL 60148-6158. Internet: <http://www.comptia.org>
- International Society of Certified Electronics Technicians, 3608 Pershing Ave., Fort Worth, TX 76107. Internet: <http://www.iscet.org>
- Electronics Technicians Association, 502 North Jackson, Greencastle, IN 46135. Internet: <http://www.eta-sda.com>

## Electrical and Electronics Installers and Repairers

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### Significant Points

- Knowledge of electrical equipment and electronics is necessary for employment; many applicants complete 1 to 2 years at vocational schools and community colleges, although some less skilled repairers may have only a high school diploma.
- Projected employment growth will be slower than average, but varies by occupational specialty.
- Job opportunities will be best for applicants with a thorough knowledge of electrical and electronic equipment, as well as repair experience.

### Nature of the Work

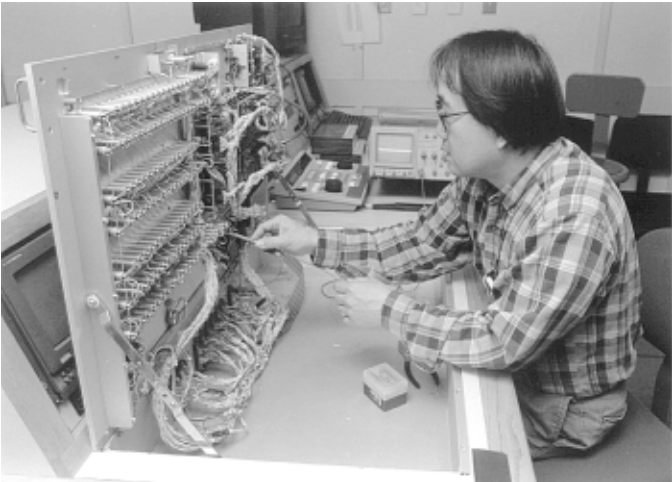
Businesses and other organizations depend on complex electronic equipment for a variety of functions. Industrial controls automatically monitor and direct production processes on the factory floor. Transmitters and antennae provide communications links for many organizations. Electric power companies use electronic equipment to operate and control generating plants, substations, and monitoring equipment. The Federal Government uses radar and missile control systems to provide for the national defense and to direct commercial air traffic. These complex pieces of electronic equipment are installed, maintained, and repaired by electrical and electronics installers and repairers.

Electrical equipment and electronics equipment are two distinct types of industrial equipment, although much equipment contains both electrical and electronic components. In general, electrical portions of equipment provide the power for the equipment while electronic components control the device, although many types of equipment still are controlled with electrical devices. Electronic sensors monitor the equipment and the manufacturing process, providing feedback to the programmable logic control (PLC) that controls the equipment. The PLC processes the information provided by the sensors and makes adjustments to optimize output. To adjust the output the PLC sends signals to the electrical, hydraulic, and pneumatic devices that power the machine—changing feed rates, pressures, and other variables in the manufacturing process. Many installers and repairers, known as *field technicians*, travel to factories or other locations to repair equipment. These workers often have assigned areas where they perform preventive maintenance on a regular basis. When equipment breaks down, field technicians go to a customer's site to repair the equipment. *Bench technicians* work in repair shops located in factories and service centers. They work on components that cannot be repaired on the factory floor.

Some industrial electronic equipment is self-monitoring and alerts repairers to malfunctions. When equipment breaks down, repairers first check for common causes of trouble, such as loose connections or obviously defective components. If routine checks do not locate the trouble, repairers may refer to schematics and manufacturers' specifications that show connections and provide instructions on how to locate problems. Automated electronic control systems are increasing in complexity, making diagnosing problems more challenging. Repairers use software programs and testing equipment to diagnose malfunctions. They use multimeters, which measure voltage, current, and resistance; advanced multimeters also measure capacitance, inductance, and current gain of transistors. They also use signal generators that provide test signals, and oscilloscopes that graphically display signals. Repairers use handtools such as pliers, screwdrivers, soldering irons, and wrenches to replace faulty parts and to adjust equipment.

Because component repair is complex and factories cannot allow production equipment to stand idle, repairers on the factory floor usually remove and replace defective units, such as circuit boards, instead of fixing them. Defective units are discarded or returned to the manufacturer or to a specialized shop for repair. Bench technicians at these locations have the training, tools, and parts to thoroughly diagnose and repair circuit boards or other complex components. These workers also locate and repair circuit defects, such as poorly soldered joints, blown fuses, or malfunctioning transistors.

Electrical and electronics installers often fit older manufacturing equipment with new automated control devices. Older manufacturing machines are frequently in good working order, but are limited by inefficient control systems that lack replacement parts. Installers replace old electronic control units with new PLCs. Setting up and installing a new PLC involves connecting it to different



Electrical and electronics repairers use multimeters to measure electrical current.

sensors and electrically powered devices (electric motors, switches, pumps) and writing a computer program to operate the PLC. Electronics installers coordinate their efforts with other workers installing and maintaining equipment. (See the statement on industrial machinery installation, repair, and maintenance workers elsewhere in the *Handbook*.)

*Electronic equipment installers and repairers, motor vehicles* have a significantly different job. They install, diagnose, and repair communications, sound, security, and navigation equipment in motor vehicles. Most installation work involves either new alarm or sound systems. New sound systems vary significantly in cost and complexity of installation. Replacing a head unit (radio) with a new computer disc (CD) player is quite simple, requiring removing a few screws and connecting a few wires. Installing a new sound system with a subwoofer, amplifier, and fuses is far more complicated. The installer builds a box, of fiberglass or wood, designed to hold the subwoofer and to fit in the unique dimensions of the automobile. Installing sound-deadening material, which often is necessary with more powerful speakers, requires an installer to remove many parts of a car (seats, carpeting, interiors of doors), add sound-absorbing material in empty spaces, and reinstall the interior parts. They also run new speaker and electrical cables. Additional electrical power may require additional fuses; a new electrical line to be run from the battery, through a newly drilled hole in the fire wall into the interior of the vehicle; or an additional or more powerful alternator and/or battery.

Repairing automotive electronic equipment is similar to other electronic installation and repair work. Multimeters are used to diagnose the source of the problem. Many parts often are removed and replaced, rather than repaired. Many repairs are quite simple, only requiring a fuse to be replaced. Motor vehicle installers and repairs work with an increasingly complex range of electronic equipment, including DVD players, VCRs, satellite navigation equipment, passive security tracking systems, and active security systems.

**Working Conditions**

Many electrical and electronics installers and repairers work on factory floors where they are subject to noise, dirt, vibration, and heat. Bench technicians work primarily in repair shops where the surroundings are relatively quiet, comfortable, and well-lighted. Field technicians spend much time on the road, traveling to different customer locations.

Because electronic equipment is critical to industries and other organizations, repairers work around the clock. Their schedules may include evening, weekend, and holiday shifts; shifts may be assigned on the basis of seniority.

Installers and repairers may have to do heavy lifting and work in a variety of positions. They must follow safety guidelines and often wear protective goggles and hardhats. When working on ladders or on elevated equipment, repairers must wear harnesses to prevent falls. Before repairing a piece of machinery, these workers must follow procedures to insure that others cannot start the equipment during the repair process. They also must take precautions against electric shock by locking off power to the unit under repair.

Electronic equipment installers and repairers, motor vehicles normally work indoors in well-ventilated and -lighted repair shops. Minor cuts and bruises are common, but serious accidents usually are avoided when safety practices are observed.

**Employment**

Electrical and electronics installers and repairers held about 171,000 jobs in 2000. The following tabulation breaks down employment by occupational specialty.

Electrical and electronics repairers, commercial and industrial equipment .....	90,000
Electric motor, power tools, and related repairers .....	37,000
Electrical and electronics repairers, powerhouse, substation, and relay .....	18,000
Electrical and electronics installers and repairers, transportation equipment .....	14,000
Electronic equipment installers and repairers, motor vehicles .....	13,000

Many repairers worked for wholesale trade companies, general electrical work companies, the Federal Government, electrical repair shops, and manufacturers of electronic components and accessories and communications equipment.

**Training, Other Qualifications, and Advancement**

Knowledge of electrical equipment and electronics is necessary for employment. Many applicants gain this training through programs lasting 1 to 2 years at vocational schools and community colleges, although some less skilled repairers may have only a high school diploma. Entry-level repairers may work closely with more experienced technicians who provide technical guidance.

Installers and repairers should have good eyesight and color perception in order to work with the intricate components used in electronic equipment. Field technicians work closely with customers and should have good communications skills and a neat appearance. Employers also may require that field technicians have a driver's license.

The International Society of Certified Electronics Technicians (ISCET) and the Electronics Technicians Association (ETA) administer certification programs for electronics installation and repair technicians. Repairers may specialize—in industrial electronics, for example. To receive certification, repairers must pass qualifying exams corresponding to their level of training and experience. Both programs offer associate certifications to entry-level repairers.

Experienced repairers with advanced training may become specialists or troubleshooters who help other repairers diagnose difficult problems. Workers with leadership ability may become supervisors of other repairers. Some experienced workers open their own repair shops.

### Job Outlook

Job opportunities should be best for applicants with a thorough knowledge of electrical equipment and electronics, as well as repair experience. Overall employment of electrical and electronics installers and repairers is expected to grow more slowly than the average for all occupations over the 2000-10 period, but varies by occupational specialty. In addition to employment growth, many job openings should result from the need to replace workers who transfer to other occupations or leave the labor force.

Average employment growth is projected for electrical and electronics installers and repairers of transportation equipment. Commercial and industrial electronic equipment will become more sophisticated and used more frequently, as businesses strive to lower costs by increasing and improving automation. Companies will install electronic controls, robots, sensors, and other equipment to automate processes such as assembly and testing. As prices decline, applications will be found across a number of industries, including services, utilities, and construction, as well as manufacturing. Improved equipment reliability should not constrain employment growth, however; companies increasingly will rely on repairers, because any malfunction that idles commercial and industrial equipment is costly.

Employment of electronics installers and repairers of motor vehicles also is expected to grow about as fast as average. Motor vehicle manufacturers will install more and better sound, security, entertainment, and navigation systems in new vehicles, limiting employment growth for after-market electronic equipment installers. However, repairing the new electronic systems should help drive employment growth.

On the other hand, employment of electric motor, power tool, and related repairers is expected to grow more slowly than average. Improvements in electrical and electronic equipment design should limit job growth by simplifying repair tasks. More parts are being designed to be easily disposable, further reducing employment growth.

Employment of electrical and electronics installers and repairers, powerhouse, substation, and relay is expected to decline slightly. Consolidation and privatization in utilities industries should improve productivity, reducing employment. Newer equipment will be more reliable and easier to repair, further limiting employment.

### Earnings

Median hourly earnings of electrical and electronics repairers, commercial and industrial equipment were \$17.75 in 2000. The middle 50 percent earned between \$13.92 and \$21.32. The lowest 10 percent earned less than \$10.90, and the highest 10 percent earned more than \$25.78.

Median hourly earnings of electric motor, power tool, and related repairers were \$15.80 in 2000. The middle 50 percent earned between \$11.91 and \$20.04. The lowest 10 percent earned less than \$9.13, and the highest 10 percent earned more than \$25.17.

Median hourly earnings of electrical and electronics repairers, powerhouse, substation, and relay were \$23.34 in 2000. The middle 50 percent earned between \$19.07 and \$26.21. The lowest 10 percent earned less than \$14.79, and the highest 10 percent earned more than \$29.00.

Median hourly earnings of electrical and electronics repairers, transportation equipment were \$16.93 in 2000. The middle 50 percent earned between \$12.25 and \$21.54. The lowest 10 percent earned less than \$9.60, and the highest 10 percent earned more than \$25.76.

Median hourly earnings of electronics installers and repairers, motor vehicles were \$12.06 in 2000. The middle 50 percent earned between \$9.60 and \$15.25. The lowest 10 percent earned less than \$7.98, and the highest 10 percent earned more than \$18.69.

### Related Occupations

Workers in other occupations who install and repair electronic equipment include broadcast and sound technicians and radio operators; computer, automated teller, and office machine repairers; electronic home entertainment equipment installers and repairers; and radio and telecommunications equipment installers and repairers. Industrial machinery installation, repair, and maintenance workers also install, maintain, and repair industrial machinery.

### Sources of Additional Information

For information on careers and certification, contact:

- International Society of Certified Electronics Technicians, 3608 Pershing Ave., Fort Worth, TX 76107-4527. Internet: <http://www.iscet.org>
- Electronics Technicians Association, 502 North Jackson, Greencastle, IN 46135. Internet: <http://www.eta-sda.com>

## Electronic Home Entertainment Equipment Installers and Repairers

(O\*NET 49-2097.00)

### Significant Points

- Employment is expected to decline because it often is cheaper to replace than to repair equipment.
- Job opportunities will be best for applicants with knowledge of electronics and related hands-on experience.

### Nature of the Work

Electronic home entertainment equipment installers and repairers, also called *service technicians*, repair a variety of equipment, including televisions and radios, stereo components, video and audio disc players, video cameras, and videocassette recorders. They also repair home security systems, intercom equipment, and home theater equipment, which consist of large-screen televisions and sophisticated, surround-sound systems.

Customers usually bring small, portable equipment to repair shops for servicing. Repairers at these locations, known as *bench technicians*, are equipped with a full array of electronic tools and parts. When larger, less mobile equipment breaks down, customers may pay repairers to come to their homes. These repairers, known as *field technicians*, travel with a limited set of tools and parts, and attempt to complete the repair at the customer's location. If the repair is complex, technicians may bring defective components back to the repair shop for a thorough diagnosis and repair.

When equipment breaks down, repairers check for common causes of trouble, such as dirty or defective components. Many repairs consist of simply cleaning and lubricating equipment. For example, cleaning the tape heads on a videocassette recorder will prevent tapes from sticking to the equipment. If routine checks do not locate the trouble, repairers may refer to schematics and manufacturers' specifications that provide instructions on how to locate problems. Repairers use a variety of test equipment to diagnose and identify malfunctions. They use multimeters to detect short circuits, failed capacitors, and blown fuses by measuring the voltage, current, and resistance. They use color bar and dot generators to provide onscreen test patterns, signal generators to test signals, and oscilloscopes and digital storage scopes to measure complex waveforms produced by electronic equipment. Repairs may involve removing and replacing a failed capacitor, transistor, or fuse. Repairers use handtools such as pliers, screwdrivers, soldering irons,